The

Kentucky Geological Survey

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

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The Sixth
Geological Survey
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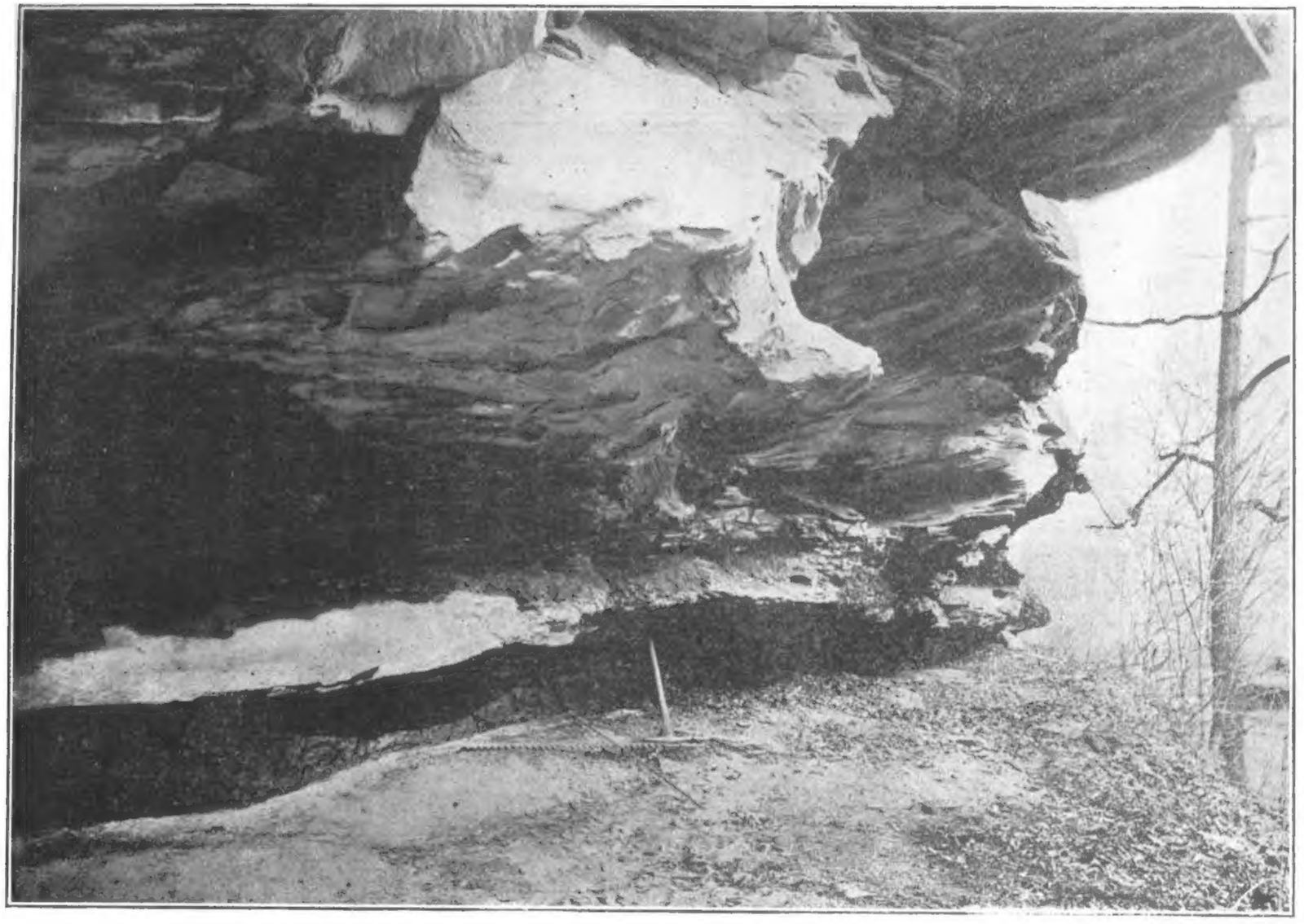

THE WHITESBURG COAL AND SANDSTONE "ROCKHOUSE" ROOF.

This characteristic view of the well known Whitesburg coal and its superimposed thirty feet of cliff forming sandstone may be seen on Otter Creek just above its juncture with the Middle Fork of the Kentucky River in Perry County.

THE
SIXTH GEOLOGICAL SURVEY

An Administrative Report of the Several Mineral Resource and General Geological Investigations Undertaken and Completed in Kentucky during the Biennial Period 1920-1921

By

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

PRESENTED WITH TEN SEPARATE MISCELLANEOUS GEOLOGICAL PAPERS

BY

GEORGE P. MERRILL,
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STUART ST. CLAIR
AND
CHARLES STEVENS CROUSE

Illustrated with 101 Photographs Maps and Diagrams

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PREFACE

Applied geology is of great economic value to every State in which natural resources are only partly developed. This is especially true of Kentucky where the great body of mineral resources are now less than 20% under commercial operation. An ideal arrangement would be one where the State would have completed the base (topographic) mapping and the preliminary geological-resource surveys prior to the opening up of any oil, coal, natural gas, asphalt or other field. During the period of proving up such a field, State employed geologists could well work hand in hand with the operators, and assist them greatly in their efforts to win the resources desired.

Unfortunately this ideal arrangement has never existed in Kentucky, though it has to some extent in other States. With only 46% of Kentucky base (topographic) mapped, and with an area approximating that of sixty counties not covered by any accurate maps at all, the function of the Kentucky Geological Survey has always been crippled and held in restraint. The day of a 100% efficiency of the Kentucky Geological Survey seems yet to be in the distant future.

During the last biennium a large number of subjects of great economic value to this State have been investigated, however, by the Kentucky Geological Survey. A full account of these investigations is presented herewith in the first paper of this volume entitled, "The Sixth Geological Survey." A number of these economic papers are included within the covers of this book, and should assist materially in an understanding of the geology and resources of the several regions covered. This report is issued in an original edition of one thousand copies.

W. R. Jillson

Director and State Geologist.

Old Capitol,
Frankfort, Kentucky.
December 15, 1921.

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OIL AND GAS POSSIBILITIES OF "THE JACKSON PURCHASE" REGION

By Willard Rouse Jillson,

Director and State Geologist.

LOCATION AND FIELD WORK.

Widely known throughout the lower Mississippi Valley as "The Jackson Purchase" because of the treaty by means of which General Andrew Jackson bought it from the Chickasaw Indians in 1818, that broad, westernmost area of Kentucky which lies beyond the Tennessee River, and includes seven separate counties, has within the last year become a field for somewhat widespread oil and gas prospecting. Though only unfavorable results have been obtained to date, this large portion of the State, containing 2,340[1] square miles, offers an extensive virgin territory for further oil and gas prospecting and development, in the event it can be shown that these mineral resource necessities occur here in commercial quantities.

"The Purchase" region is bounded on the south by 36° 30′ north latitude, and on the north by 37° 15′ north latitude; on the east by 88° west latitude, and on the west by 90° west latitude. Its natural boundaries are principally major waterways: the Tennessee River on the east, the Ohio and Tennessee Rivers on the north, and the Mississippi and Ohio Rivers on the west. The south boundary is the Walker line, which follows with slight deviation the parallel 36° 30′ north latitude from the Tennessee River to the Mississippi River. Its prin-

[1] "The Jackson Purchase" Region, by R. H. Loughridge, Kentucky Geological Survey 1888.

THE MISSISSIPPI RIVER FROM HICKMAN.

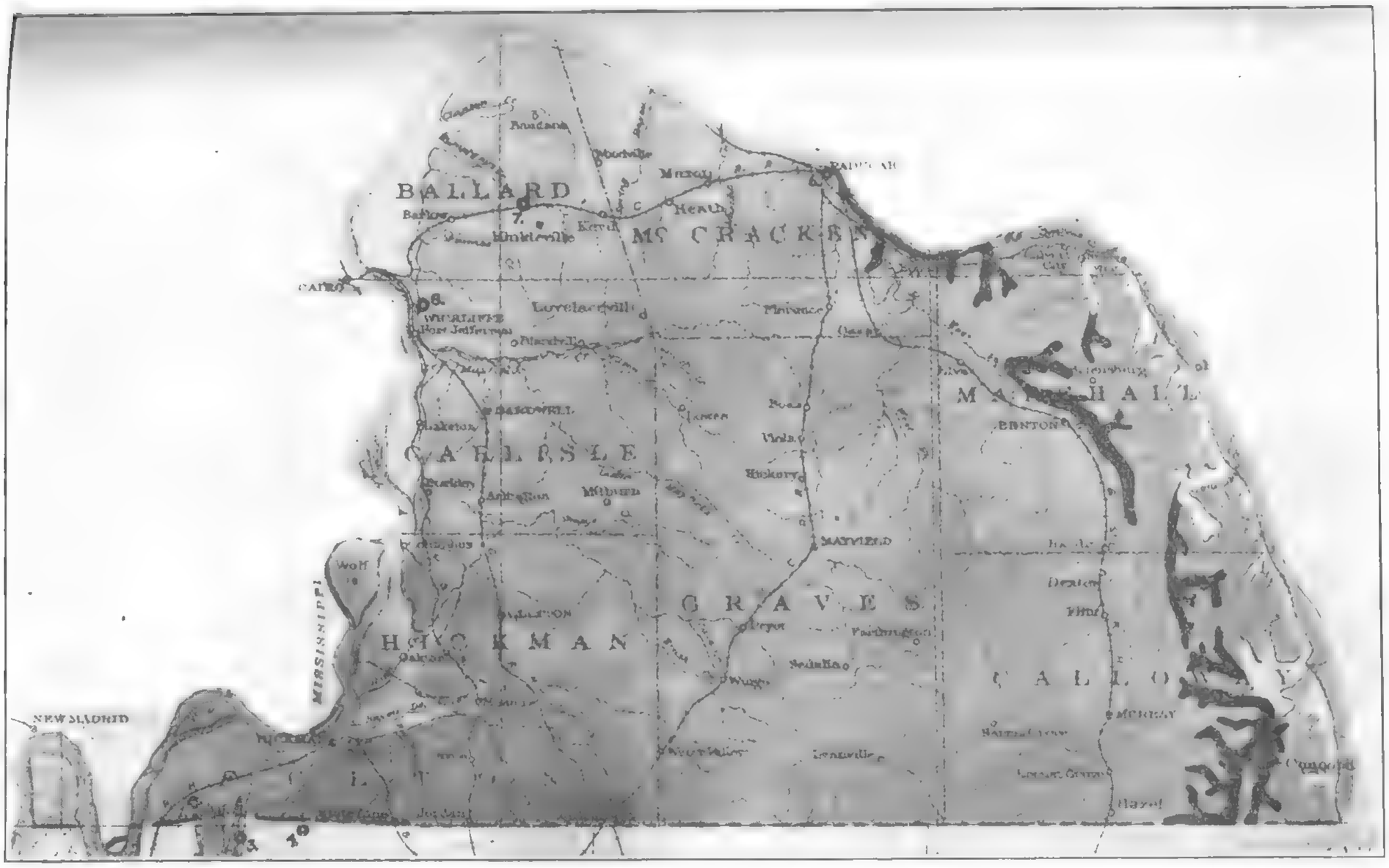
The high bluffs at Hickman give one an excellent panorama of the topography of Western Fulton and Hickman Counties in the Purchase Region.

cipal city is Paducah, a town of 24,735 inhabitants,[2] located at the junction of the Tennessee and the Ohio Rivers. Mayfield, Hickman, Murray, Wickliffe, Clinton, and Benton, are county seats of secondary importance, ranking in the order named. The field work on which this report is based was done by the writer personally in June, 1920, during which time a complete reconnaissance of the "Purchase" region was made.

TOPOGRAPHY AND DRAINAGE.

As part of the old Gulf Embayment section of the lower Mississippi Valley, the greater portion of the sediments of which are unconsolidated and at a relatively slight elevation above the present drainage levels of the Mississippi River, the topography of the area considered is uniformly rolling, with little or no sharp configuration, except in the lower courses of the major creeks of the region, or adjoining the Mississippi River. Excellent examples of such rough and broken topography as occur in this section are to be found along Mayfield Creek

[2] 1920 Census.



GEOLOGIC MAP OF THE PURCHASE REGION.

The light areas along the Eastern Border are Mississippian, the dark areas Cretaceous, and the large mottled area Quaternary. The light stippled area along the Mississippi River is Recent in age.

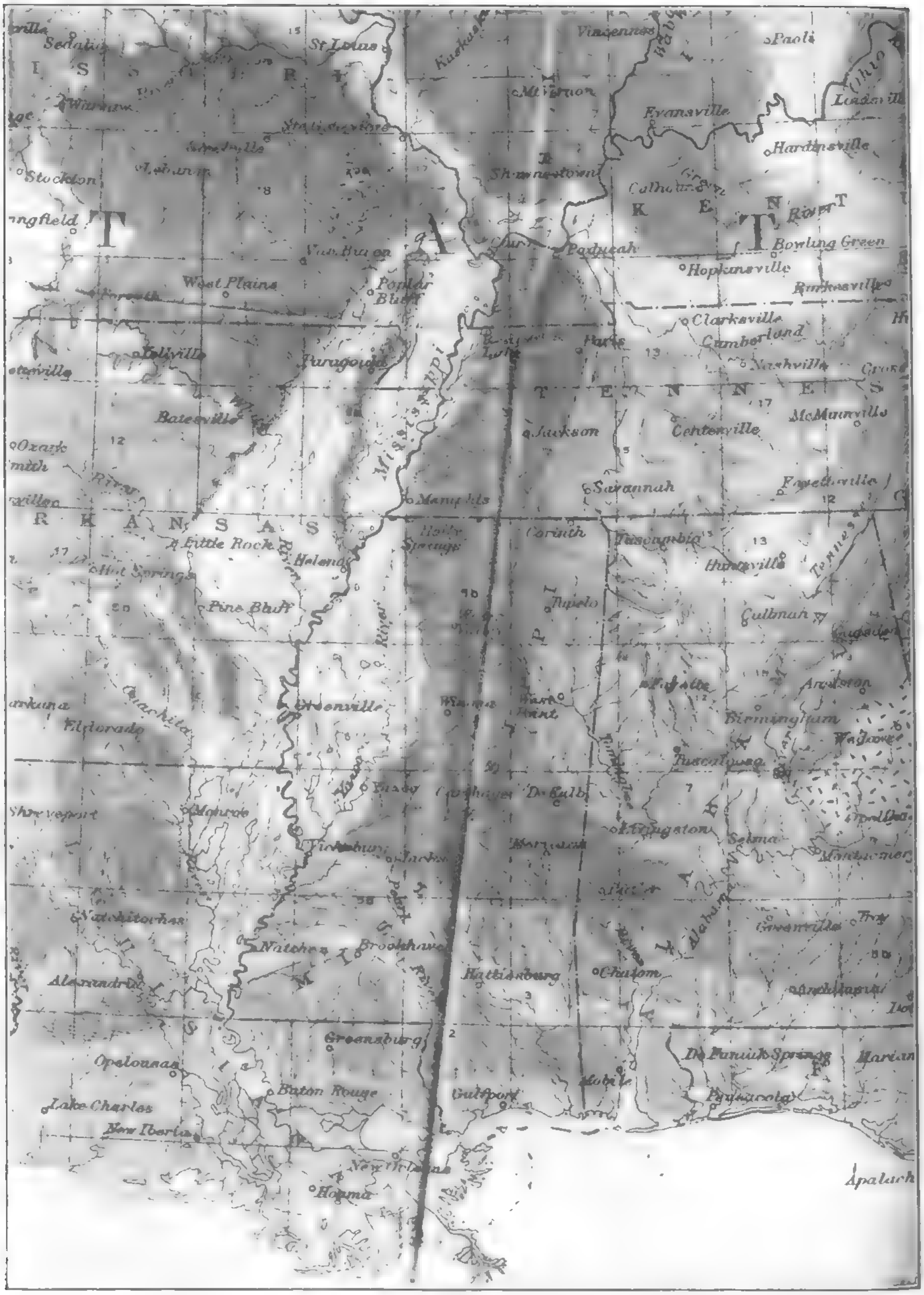
from the McCracken County line to the stream's debouchure into the Mississippi River. This is also true for short distances along the lower portions of Humphrey's and Obion Creeks, and is the principal characteristic along the Mississippi River bluffs from a point some distance north of Wickliffe, south along the east bank of the river, to Hickman and the Tennessee line. These Mississippi River bluffs range in height from 50 to 170 feet, the latter elevations being characteristic of the Hickman section. A very broken topographic figure is the characteristic along the Tennessee River in Calloway and Marshall Counties. The relief here, however, is not as sharp as it is in the west along the Mississippi River. The highest elevation in the Purchase region is a section in the southwestern part of Calloway County, west and southwest of Murray, which is 600 feet above sea level. This region extends northwestward to Linnville, thence lowering gradually it continues northwestward to points west of Mayfield, which attain elevations of 450 and 500 feet. As a topographic high it extends southward from the vicinity of Crossland into Henry

MOUTH OF THE OHIO RIVER.

Standing out on the lowest flood plain west of Wickliffe in Ballard County one sees the juncture of the Ohio and Mississippi Rivers. On the right the low Recent flood plain can be seen merging into the higher plateau of Quaternary age.

County, Tennessee, where it attains its broadest figure as a plateau. This broad upland is surrounded by two undulating plateau regions showing elevations between 450 and 500 feet. Low water at Paducah is 286 feet, and the city has an altitude of 341 feet. The lowest point within this area is found at low water in the Mississippi River, at the Kentucky-Tennessee line, which is about 245 feet, the elevation of low water, at Hickman, being 256 feet.

The major drainage of the Purchase region bounds it on three sides, and consists of the Tennessee, Ohio and Mississippi Rivers, to which all interior drainage is tributary. The smaller drainage in Calloway, Marshall, eastern McCracken, and northern and eastern Graves Counties, consists of Blood River, Jonathan Creek, and Clark's river, all of which flow to the north and are tributaries to the Tennessee River. Western McCracken County, through Massac Creek and Spring Bayou, drains directly into the Ohio River. Ballard County, in the northern portion, is drained by Humphreys Creek, and in its central portion is drained by Mayfield Creek, the largest of the interior drainage units. Hickman and Fulton are drained principally by Obion Creek and Bayou de Chien, which are tributaries to the Mississippi River just above Hickman townsite. These latter streams find their headwaters in southern Graves County.



REGION OF OLD GULF EMBAYMENT.

The straight dark lined area at the east of the Mississippi River is Cretaceous, the light dotted area at the west and south is Recent. The head of the old Gulf near Cairo and Paducah is well shown.

STRATIGRAPHY.

The surficial rocks of the area considered consist of limestones, sands, clays, and gravels, that range in age from the Mississippian to Recent. The record is not one, however, of continuous and unbroken sedimentation. With the exception of the Mississippian limestones which are found exposed in the lower drainage courses of the creeks emptying into the Tennessee River in Calloway and Marshall Counties, the sedimentary deposits of the "Purchase" region are practically all soft or unconsolidated. Occasionally, however, ferruginous sandstones or conglomerates of a dark brown iron color, locally called "iron-stones," may be seen in outcrop at the surface, or found by the prospecting bit. These hard sandstones are, however, simply iron cemented lenses of small and irregular figure which may occur in any sand horizon where a downward percolation of the iron containing waters is temporarily arrested by an underlying impervious stratum of clay. These "iron-stones" are, therefore, not continuous in their extent, and are hence considered as unconsolidated sediments.

The several geological formations recognized in the sequence of the embayment sediments, and presented in their order of super-position, are: the "Eutaw" sand, "Selma" clay, Ripley sands and clays, all of which belong to the Cretaceous; the Porters Creek clays, and the Lagrange sandstones, which are Eocene; the "Lafayette" sands and gravels of the Pliocene; the "Columbia" sand and loess of the Pleistocene; and the stream and river alluvium of Recent and Present age. All of these sediments in the order as given, though in varying thicknesses, due to the nature of their deposits, are supported by the older Mississippian limestones which completely underlie the area. These latter consolidated sediments are spoken of in the literature as forming a part of the Paleozoic floor or bench underlying the embayment deposits of the old Gulf, which found its head in Cretaceous times in the vicinity of Cairo, Ill.*

*Upper Cretaceous Floras of the Eastern Gulf Region in Tennessee, Mississippi, Alabama, and Georgia. E. W. Berry, U. S. Geo. S. Prof., p. 112, 1919.

HILLMAN FERRY OVER THE TENNESSEE RIVER.

On the right may be seen the steep high cliffs of the hard Mississippian Limestones of Lyon County, and on the left which is west the characteristically low plateau of Marshall County and the Northern Region generally.

PALEOZOIC ROCKS.

The lithological characteristic, structural figure, and stratigraphic sequence of the several formations comprising the Paleozoic series underlying the "Jackson Purchase" region has long been a matter of much interest and speculation to artesian water and oil and gas prospectors. Unfortunately, due to the rapid thickening of the embayment deposits (Cretaceous, Tertiary, Recent), and the almost complete blanketing of these older Paleozoic consolidated sediments, little has been known until recently of the structural configuration of the Mississippian and lower formations beneath this area. In the progress of recent oil well drilling in Fulton County, Kentucky, and Obion and Lake Counties, Tennessee, in the section adjoining Reel Foot Lake, the Mississippian limestones have within the last month or so been encountered at greater depth than ever before experienced in this broad region. Calculations based on these discoveries allow an interesting interpretation of the structural figure assumed by the Paleozoic floor.

STRUCTURE.

Where the Mississippian limestones go under the cover of Cretaceous sediments on the eastern side of the "Purchase" region they are found to be dipping at the rate of between 25 and 30 feet to the mile. This rate of dip, if projected across the "Purchase" region to the Reel Foot Lake section, would place the top of the Mississippian limestone in the Reel Foot Lake section at about 2,000 to 2,100 feet below the surface there. It is interesting in this connection to note that the well now being drilled at Bondrant Station, on the C. M. & G. Railroad, 8 miles southwest of Hickman, and one mile north of Reel Foot Lake, in Fulton County, Kentucky, by Roney-Mitchell-Bruer, encountered the Mississippian limestone at a depth ranging between 2,270 and 2,300 feet, the exact point of which has not been accurately determined, due to inability to examine the drill cuttings.

The slight difference between the computed depth of the Mississippian limestone and the actual depth at which it was

QUATERNARY GRAVELS OF THE PURCHASE REGION.
These gravels, frequently iron stained and cemented, form the surficial sediments of large portions of Marshall and Calloway Counties and are used to good advantage in road construction especially in low or boggy creek bottoms.

found may be disregarded, since the difference between the topographic elevation of the point of disappearance of the limestone in the east and the casing head elevation of the well might easily offset this error. Under the City of Paducah the Mississippian limestone was found in an old gas well drilled in 1888[3] at a depth of 335 feet. At La Center on the I. C. Railroad in central Ballard County, Kentucky, the Mississippian chert was found at 387 feet,[4] which depth would indicate that the consolidated limestones of the Mississippian would occur at about 400 feet at the same point. At Wickliffe, in Ballard County, Kentucky, a well is reported to have entered the Mississippian limestone at a depth of 1,000 feet. The configuration of the Paleozoic floor as based on this data, represents it as a great subsurface plane gradually sloping to the southwest. The dip would be almost due west from Murray, southwest

[3] "Jackson Purchase," by Loughridge, Kentucky Geological Survey, 1888.
[4] Underground Waters of Tennessee and Kentucky, W-S. Paper, No. 164, L. C. Glenn, 1906, p 22.

from Paducah, and slightly west of south from Wickliffe, Kentucky, or Cairo, Ill. As to the uniformity of the dip, no positive statement can be made, but there is reason to believe that it is not uniform, even in a general way. Flatter dips in the vicinity of the Mississippi River in Carlisle, Hickman and Fulton Counties may be reasonably inferred as the natural resultant of a line of semi-concentric scarping following geographic configuration of the Ohio and Tennessee Rivers, and extending southwestward from the middle of Ballard County, through Graves and into eastern Weakley County, Tennessee. Support to such a theory is given by the records of wells drilled at La Center and Wickliffe in Ballard County. The lack of a strictly uniform dip is proven by the occurrence of the Mississippian limestone in the Bondrant well at slightly greater depth than calculated from the observed dips along the eastern outcrop.

The sequence of the Mississippian and Devonian sediments that might be expected to be encountered underneath the "Purchase" region is based upon the observations of the clos-

A RUSTIC HOME IN MARSHALL COUNTY.

The log cabin county home with "stick an' mud" chimney is frequently seen in the hilly parts of Marshall and Calloway Counties in the eastern part of the Purchase Region. Happiness and contentment generally abides within.

est outcrops in the area surrounding to the north and east in Kentucky and Illinois, and is as follows:

GEOLOGICAL SECTION OF PENNSYLVANIAN, MISSISSIPPIAN & DEVONIAN SEDIMENTS COMPUTED FROM OUTCROP OBSERVATIONS IN WESTERN KENTUCKY & SOUTHERN ILLINOIS FOR THE JACKSON PURCHASE REGION OF KENTUCKY.

Pennsylvanian System.

Pottsville Series (basal).

Trade Water Formation.[1]

Shale and sandstone with two thin coal seams and a six-inch layer of yellow limestone. Much of the sandstone is more or less massively bedded, coarse, friable and felspathic. Full thickness of the formation 594 feet.

Caseyville Formation.[1]

Conglomerate, sandstone and shale, the pebbles of the conglomerate beds being of white quartz, smoothly rounded. In places a two-foot bed of coal is present about 125 feet from the top of the formation. Full thickness about 400 feet.

GREAT UNCONFORMITY.

Mississippian System.[2]

Chester Series.

Kinkaid Limestone.

Interbedded limestone and shale. The limestone beds commonly one foot more or less in thickness, the shale beds from a few inches to several feet in thickness. The limestone is variable in character, gray to blue or almost black in color, mostly hard and compact, with little or no crystalline members. A thin sandstone member is present in places, and locally there are massive chert beds in the lower portions of the formation. Maximum thickness about 180 feet.

Degonia Sandstone.

Yellowish brown sandstone, perhaps lighter colored under cover, varying from massively bedded to thinly bedded or even arenaceous shales in places. Thickness ranging from 30 to 100 feet.

Clore Limestone.

Lithologic character exceedingly variable in character, in places nearly all shale with thin limestone beds, elsewhere with more limestone which is commonly nonerystalline, and rather hard and compact in texture. Thickness about 40 feet.

---

[1]These Pennsylvanian formations may occur locally under the Cretaceous of the Purchase Region of Kentucky due to fauling. They are not widely distributed, however.

[2]The divisions made follow the interpretations of Stuart Weller.

Palestine Sandstone.

Rather fine grained, yellowish brown sandstone, in places with a pinkish tint. Bedding varying from massive to thin with small arenaceous shale layers locally. Thickness 50 to 100 feet.

PANORAMA IN HICKMAN COUNTY.

The gently undulating figure of the topography in the vicinity of Clinton is well illustrated in this view five miles south of Clinton.

Menard Limestone.

Mostly hard, compact limestone, gray, blue to almost black in color, slightly or noncrystalline, in layers one foot, more or less, in thickness, separated by shale beds from a few inches to several feet in thickness. A much greater amount of shale is commonly present in the lower portion of the formation, with more massive limestone beds in the higher portion. A small amount of chert may be present. Thickness 80 to 120 feet.

Waltersburg Sandstone.

Sandstone variable in character, from very massive, cliff-making beds to thinly bedded layers, which break up into sliver-like fragments. Much of the sandstone is yellowish to brown in color, but where the formation is thin the fresh beds are nearly black in some places. Much dark, sandy shale is associated with the sandstone in places. Thickness 10 to 60 feet.

Vienna Limestone.

An exceedingly silicious limestone below with much chert in thin layers in surface outcrops, passing into dark carbonaceous, or gray clay shales above. Thickness 40 to 60 feet.

Tar Springs Sandstone.

A formation made up of several more or less massive beds of sandstone separated by more shaly members. The sandstones vary from white to yellowish brown in color, and are commonly rather fine texture. The shale members are arenaceous or argillaceous in character, and an impure coal seam from an inch or two to two feet in thickness is a rather persistent member of the middle portion of the formation. Thickness from 40 to not more than 200 feet.

MIDDLE CHESTER GROUP.

Glen Dean Limestone.

Varying proportions of limestone and shale. Limestone beds commonly more or less crystalline, locally oolitic in texture, gray to blue in color. The shale beds variable in character, commonly blue or nearly black to gray in color, and argillaceous in composition. The formation may be comprised almost exclusively of limestone, or it may be nearly all shale, the changes in character being very abrupt in places. Thickness 30 to 70 feet.

Hardinsburg Sandstone.

Rather fine grained, yellowish brown sandstone in thick or thin beds. In places the formation includes a notable arenaceous shale member in its middle portion. Thickness 25 to 100 feet.

Golconda Limestone.

Limestone and shale in varying proportions. The limestone beds are exceedingly variable in character, but are commonly gray to dark blue in color, and more or less crystalline. In places there are notable beds of white oolite. Fossils are abundant with many bryozoans and crinoid stones. Some beds of more compact, nonerystalline limestone may be present. The shales are also variable in character, black, gray, and in places red in color, mostly agrillaceous, but somewhat arenaceous shales may be present locally, especially in the lower portion of the formation. The proportions of limestone and shale vary greatly. In places 50% or more of the formation may be limestone, elsewhere less than 10%. Thickness from 30 to 175 feet.

Cypress Sandstone.

Yellowish brown, rather fine textured sandstone, in massive or thin beds. Commonly without shale partings. Thickness 30 to 110 feet.

LOWER CHESTER GROUP.

Paint Creek Limestone.

A limestone and shale formation exceedingly variable in character. The limestone is commonly gray to white in color, and is crystalline, oolitic or compact in texture, some beds very argillaceous. In places nearly the whole of the formation is fissile black or greenish shale. Elsewhere it is almost wholly limestone. In the typical locality in southwestern Illinois there is a notable deep-red clay or shale bed. Thickness 40 to 100 feet.

Bethel Sandstone.

Massive to thin-bedded sandstone, moderately fine in texture, yellowish brown in color. Similar in character to the Cypress sandstone. Represented in the Mississippi Valley sections by a more or less quartzitic chert bed, the Yankeetown chert. Thickness 10 to 100 feet.

Renault Limestone.

A limestone and shale formation in the Ohio valley, but including some sandstone members in the Mississippi River sections. The limestones variable in character, commonly blue to gray in color, crystalline or compact in texture, in places with considerable oolite. The shales commonly gray in color, thinner than the limestone portions of the formation. Thickness about 100 feet.

Aux Vases Sandstone.

This formation is wanting in the Ohio valley. It is a yellowish brown, fine textured sandstone similar to other sandstones of the Chester Series. Thickness 0 to 80 feet.

Iowa Series.

Meramec Group.

St. Genevieve Limestone.

Mostly light colored, oolitic limestones, with some darker beds of more or less compact or crystalline limestone, and some minor shale partings. In the upper portion of the formation a very persistent sandstone member, the Rosiclaire sandstone, from 20 to 25 feet thick, is present. Thickness 150 to 200 feet.

St. Louis Limestone.

Bluish gray to black, compact, more or less silicious limestone, not known to be oolitic. Thickness 350 feet.

Spergen or Salem Limestone.

Light colored oolitic or crystalline limestone, in most places non-silicious. Thickness 150 feet.

Warsaw Limestone.

More or less impure shaly limestone, somewhat silicious. Mostly dark gray to blue in color, and more or less crystalline in texture. The shale beds argillaceous and more or less silicious. Thickness 50 to 100 feet.

Osage Group.

Keokuk and Burlington Limestones.

Light colored, crystalline limestone with great quantities of chert. In places the chert contributes 50% or more of the contents of certain beds. Thickness 200 to 500 feet.

Kenderhook Group.

This basal group of the Iowa Series of the Mississippian is not well developed in the Ohio Valley. It is likely to be comprised of a variable series of beds, perhaps comprising limestones, sandstones and shales. Its thickness is probably not great, perhaps 50 feet, and probably even thinner than this.

Devonian.

Chattanooga Shale.

Black, more or less fissle, carbonaceous shale. Thickness 400 feet in Hardin County, Illinois.

Devonian Limestone.

Beneath the Chattanooga shales is a series of Devonian limestones which must represent the Grand Tower limestone of southern Illinois, Middle Devonian in age, and beneath these other limestones of lower Devonian age, some of which may be highly silicious. The thickness of these limestones is uncertain, but is probably 350 feet or more.

New Madrid Earthquake.

No discussion of the oil and gas possibilities of the "Purchase" region of Kentucky would be complete without an evaluation of the probable effects of the New Madrid Earthquake of 1811, and other associated earth tremors of earlier and subsequent date. While the fullest and most detailed studies and observations of such great seismic disturbances as those which it is known involved this and the much larger surrounding area of unconsolidated sediments, can never fully reveal the actual extent of structural deformation at such depths as must necessarily be included in this oil and gas consideration, there is, nevertheless, much to be gleaned of an instructive nature. In looking into the causes of that long series of seismic disturbances, including the New Madrid earthquake and later tremors, which have affected that area under discussion, causal factors of importance once placed in the unconsolidated sediments of the embayment sequence have now been thrown out.

It is now recognized that the real cause of these earth disturbances found their origin in the regional readjustments of the rocks composing the Paleozoic floor and its underlying and older sequence.[5] Such constructions predicate necessarily extended faulting of the consolidated rocks of this and adjoining regions generally. This assumption is rendered the more reasonable since it is known that many of the faults which mark the Mississippian scarp on the eastern side of the Tennessee River pass across this river and into the "Purchase" region.

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[5]The New Madrid Earthquake, Bulletin No. 494, U. S. G. S., M. L. Fuller, 1912, p. 104.

It has been suspected by Loughridge[6] that faulting to the extent of a displacement of about 1,300 feet has taken place in the Paleozoic sediments underlying the City of Paducah. There is some further confirmation of this interpretation of the sub-surface conditions in the northern part of the "Purchase" region to be secured from a detailed knowledge of the sharp block faulting of western Livingston County, Kentucky, which if projected to the southwest would pass under the City of Paducah, and very possibly give the figure of displacement suggested. Such known disturbances as these must reasonably be associated with many others of a similar and lesser scale which are completely obscured by the unconsolidated sediments found at the surface in the "Purchase" region. How far within the "Purchase" from the northwest the intensely faulted section of the consolidated rocks of the Mississippian and sub-adjacent Systems extend toward the Reel Foot Lake section, it is of course impossible to say; but that the entire region is more or less faulted appears to be without doubt the actual condition.

The disturbances of the New Madrid and other earthquakes throughout this portion of the Mississippi Valley were without doubt associated with the lines of old structure and faulting, though it is true that the surficial features observed cannot be said to have had this direct cause. In this connection it is not supposed that the domed area south of and adjoining the Reel Foot Lake section which has been responsible for the damming up of the waters of the creek which formerly occupied this area, is anything more than an expression of compression forces operating entirely within the embayment deposits themselves. It is quite impossible to associate the doming of consolidated rocks such as form the Paleozoic floor of this region with this surficial anticlinal expression, since it is known definitely that the faulting or arching of thoroughly indurated sediments is only accomplished through very long periods of geologic time. In the same category must be regarded the

[6]Jackson Purchase Report, Loughridge, Kentucky Geological Survey, 1888, p. 320.

A MARSHALL COUNTY PANORAMA.
Benton the County seat is in the middle background and the valley is that of the East Fork of Clarkes River. Characteristic Eastern Purchase Region topography.

many small faults which were noticed by various observers in the region to have occurred during the time of, or shortly following, the earthquake disturbances. Without doubt these surficial structural features represent only the adjustment of unconsolidated sediments whose mass has been set in motion after a long period of tension by the disturbances indigenous to the consolidated rocks of the Paleozoic base below them.

Results of Drillings.

A large number of wells have been drilled in the "Purchase" region for artesian water, most of which have gone only to depths of a few hundred feet, and are therefore practically useless in this consideration, since no oil or gas in commercial quantities may be expected in this whole region at such shallow depths. A few water wells such as the La Center and Wickliffe wells are of importance, since they give the depth at which consolidated sediments, in which oil and gas reservoiring sands may be contained, are found. The records of the wells now drilling, or recently completed, in oil and gas prospecting in Fulton County, Kentucky, and Obion and Lake Counties, Tennessee, are of the very greatest importance in interpreting the drilling section for the entire region, and affording information as to possible "sands," and the depths at which they might be reasonably expected at adjacent or more distant points.

The Bondrant well has shown conclusively that little indeed may be expected in the way of commercial oil and gas above 2,000 to 2,100 feet in depth in the vicinity of western Fulton County, since no thoroughly consolidated rocks which might serve as containing reservoirs for oil and gas were encountered above the Paleozoic limestones of Mississippian age. Using the information as given by the Bondrant well, which has now attained a depth of 2,645 feet, future prospecting in the "Purchase" region may well be guided as to depths and as to "sands" with great commercial advantage. Drilling records of this and several wells in McCracken, Ballard and Fulton Counties, Kentucky, are given herewith in detail, their actual

THE FULTON WELL.
It was drilled about a quarter of a mile north of the Tennessee line and just east of Fulton, Ky. A standard rig was used and the well was started with a regulation steel bit. This had to be abandoned later and rotary drilling instituted, because of the soft nature of the sediments.

sequence of sediments being interpreted stratigraphically as closely as the samples or the record would allow.

BALLARD COUNTY, KENTUCKY.

Log No. 1.

Log of Illinois Central Railroad well.[7]

Location: La Center, Ballard Co., Ky.

Strata			Thickness	Depth
Quaternary System				
Clay (loess, loam)			20	20
Tertiary System				
Sand and clay	(Lafayette)	Pliocene	18	38
Cement gravel			38	76
Sandy clay	(Lagrange)	Eocene	34	110
Marl and streaks of sand			28	138
Gumbo (Porters Creek)			112	250
Cretaceous System				
White sand	(Ripley)		5	255
Brown sand and clay			132	387
Mississippian System				
Limestone			10	397
Gumbo and "Elco" gravel, mixed	(Mississippian)		48	445
Brown sand and clay			113	558

Log No. 2.

Log of well in southern part of Wickliffe, Ballard Co., Ky.[8]

Strata			Thickness	Depth
Quaternary System				
Yellow clay and gravel			12	12
Tertiary System				
Potter's clay	(Lagrange)	Eocene	130	142
Coarse sand, clear, yellowish, or reddish			300	442
Blue marl or soapstone (Porters Creek)			158	600
Cretaceous System				
Soft sand, water bearing	(Ripley)		10	610
Blue marl with some kaolin, down to 1,000 feet depth			390	1,000
Mississippian System				
Flinty limestone (penetrated)			20	1,020

[7]W-S. & Irrigation Paper, No. 164, p. 124, Underground Waters of Tennessee and Kentucky, by L. C. Glenn, 1906.

[8]W-S. & Irrigation Paper, No. 164, p. 124, Underground Waters of Tennessee and Kentucky, by L. C. Glenn, 1906.

FULTON COUNTY, KENTUCKY.

Log No. 3.

Roney, Mitchell & Bruer, Hickman, Ky., owners and operators.

Location: 150 yds. S. E. Bondrant Station on C. M. & G. R. R., which is 8 miles S. W. Hickman, 1 mile N. Reelfoot Lake.

Drilled with rotary machine.

Driller, De Orman.

Authority: J. W. Roney.

Incomplete record: well to be drilled deeper.

Strata		Thickness	Depth
Quaternary System			
Soil		15	15
Sand		105	120
Clay		15	135
Tertiary System			
Sand	Pliocene or Miocene	20	155
Gumbo	Pliocene or Miocene	95	250
Gumbo and gravel, (10 in. casing)	Lagrange	50	300
Sand and gravel	Lagrange	50	350
Sand, brown	Lagrange	100	450
Sand, hard	Lagrange	480	930
Sand rock	Lagrange	70	1,000
Brown water sand	Lagrange	100	1,100
Sand, hard	Lagrange	240	1.340
Shale, black, and gumbo, (8 in. casing)	Porter's Creek	105	1.445
Brown rock (gas show)	Porter's Creek	6	1,451
Black Gumbo	Porter's Creek	369	1.820
Cretaceous System			
Shale, hard, and hard sand and gravel, showing some oil and gas all the way	Ripley (McNairy and Selma)	94	1.914
Shale, hard, and sand	Ripley (McNairy and Selma)	71	1.985
Limestone, hard, gray, with layers of chalk	Ripley (McNairy and Selma)	285	2.270
Strata			
Mississippian System			
Limestone, hard, gray (6-in. casing)		130	2.400
Limestone, hard, brown, green and red		300	2.700
Limestone, hard, black, pyrites and silica		200	2,900
Chalk rock, white		50	2,950
Lmestone, hard, gray, sand and brown shale (oil show)		230	3,180
Incomplete depth, Dec. 7, 1921.			3,180

NOTE: The computed thickness of the entire Mississippian Series regarded as present beneath the embayment series has been placed at from 1,800 to 2,300 feet. Accepting the base of the Cretaceous as 2,120 the base of the Missssippian and the top of the Devonian here is probably about 4,300 feet below the surface. For purposes of comparison in this little "wild catted" section of extreme western Kentucky, the record of three recent wells, all drilled near to Reelfoot Lake, in Obion and Lake Counties, Tenn., are given as follows:

LAKE COUNTY, TENNESSEE.

Log No. 4.

Reelfoot Dome Oil Co., lessor.

Location: Northwest side of Reelfoot Lake, at Proctor City.

Authority: De Armand, driller.

Strata		Thickness	Depth
Quaternary System			
Soil		10	10
Sand and gravel		135	145
Unknown, (no sample)		55	190
Clay, blue gray, sticky		20	210
Sand and clay, like buttermilk, with wood, some reddish		15	225
Tertiary System			
Quicksand		75	300
Sand, blue, little clay	Lagrange	80	380
Sand, gray		103	483
Sand		45	528
Gumbo		37	565
Sand, hard		20	585
Sand, brown, coarse		200	785
Sand, hard, and gravel		115	900
Sand rock		50	950
Shale, black		70	1,020
Sand, hard, coarse		60	1,080
Gumbo, gray		60	1,140
Sand, brown, coarse		125	1,265
Gumbo, sandy	Porter's Creek	210	1,475
Shale, black		25	1,500
Gumbo, sandy, (show of oil)		80	1,580
Shale, black		20	1,600
Shale, hard, yellow, fine shells		20	1,620
Gumbo, sandy		30	1,650
Cretaceous System			
Shale, black, with blue lime shells and white flint	Selma—McNairy and Ripley	70	1,720
Shale, blue, with hard shells of flint and pyrite		230	1,950
Shells and hard sandstone		24	1,974
Limerock		101	2,075
Total depth			2,075

Note: Stratigraphic division by W. A. Nelson, State Geologist, Tennessee Geological Survey. Selma fossils found in bottom of well.

OBION COUNTY, TENNESSEE.

Log No. 5.

Roger Well, No. 1, lessor.

Reelfoot Ranger Oil Co., lessee.

Location: 3 miles east of Walnut Log, in Obion County, Tennessee.

Collaborated authorities: J. S. Hudnall, collector of cuttings from Tennessee Geological Survey, and C. H. Richardson, mineralogical and lithological examinations. This log compiled from actual cuttings of rotary drill.

Strata		Thickness	Depth
Quaternary System			
Clay, calcareous, yellowish gray		70	70
Clay, ferruginous		20	90
Clay, calcareous, yellow		10	100
Tertiary System			
Gravel, coarse, river water rounded		40	140
Sand and gravel, river water rounded and fine		5	145
Gravel, coarse, ferruginous		10	155
Unknown (no sample collected)		145	300
Sand, silicious, fine, gray,		25	325
Sand or shale, fine, light gray		5	330
Sand, dolomitic and calcareous, and shale		25	355
Unknown		5	360
Shale, dolomitic, manganiferous and carbonaceous		30	390
Sand, fine, with carbonaceous matter		20	410
Gravel, fine, light gray		25	435
Sand and gravel (break), angular, carbonaceous		30	465
Sand, fine, and gravel, light gray	Lagrange	30	495
Sand, fine, and gravel, light gray		45	540
Gravel, ferruginous, coarse		30	570
Sand, mostly white, fine		5	575
Sand and gravel		10	585
Shale, light colored, fine quartz sand		15	600
Sand with little gravel, fine, and shale		20	620
Sand and gravel, slightly dolomitic, mollusca		25	645
Sand, coarse, subangular (break)		10	655
Sand, shale and gravel, small fossil		25	680
Sand, shale and flat limonite gravel		70	750

Strata		Thickness	Depth
Sand and gravel, coarse and fine		20	770
Sandstone, fine and coarse		100	870
Sand and gravel, some clay		30	900
Sand, white, and ferruginous gravel	Lagrange	10	910
Sand, mostly white		10	920
Sand and gravel, flat and angular, pea size		30	950
Gravel, ferruginous, (break), some sand		115	1,065
Unrecorded		140	1,205
Sand and gravel		20	1,225
Gravel and clay		10	1,235
Sand and gravel, coarse		40	1,275
Sand and gravel and clay		45	1,320
Sand, gravel, sand clear quartz		120	1,440
Sand, gravel, mostly clear quartz sand		45	1,485
Sand, quartz and gravel of sandstone	Porter's Creek	20	1,505
Sand and gravel, mostly white quartz		95	1,600
Sand, very fine		25	1,625
Sand and gravel, shaly		60	1,685
Sand, gravel and bluish shale		40	1,725
Shale, bluish gray, alumina and silica		15	1,740
Total depth			1,740

Note: There was no showing of oil in any of the above drill cuttings. "This well started on top of loess bluff and ended at 1,645 instead of 1,745, according to statement of Will Morris, one of the drillers. It finished in Porter's Creek clay of Tertiary age." W. A. Nelson, State Geologist of Tenn. If the driller's statement is true, and there is an error of 100 feet in the record, either footage may occur at the "unrecorded" 140 feet above 1,205, or "no sample" 145 feet above 300 feet in depth.

OBION COUNTY, TENNESSEE.

Log No. 6.

O. T. Wallaston, No. 1, lessor.

Reelfoot Ranger Oil Co., lessee.

Location: Walnut Log, Obion County, Tennessee.

Strata	Thickness	Depth
Quaternary System		
Surface soil	3	3
Clay, silt and sand	17	20
Quicksand	70	90
Gravel, river water worn	95	185
Clay, silt and sand	10	195
Sand, (water)	20	215

Tertiary System

		Thickness	Depth
Gravel, clay and artesian flow		30	260
Clay		15	275
Sand and clay		20	295
Sand, clay and rock		5	300
Sand and clay		10	310
Sand and gravel		20	330
Quicksand		5	335
Gravel		5	340
Gravel and sand		5	345
Sand and clay		25	370
Sand and gravel		40	410
Gravel, sand, flint, chalk rock		20	430
Clay, blue, fine, sticky		19	449
Sand and flint		31	480
Gravel		91	571
Clay, sticky, and sand	Lagrange	29	600
Gravel and sand		40	640
Clay, sticky, and sand		15	655
Sand		65	720
Sandstone, hard, some gas		5	725
Gumbo and sand		45	770
Sand		10	780
Sand and gumbo		20	800
Sand		40	840
Sand and gumbo		15	855
Sand, (asphalt)		5	860
Clay, sticky, and sand		65	925
Sand		30	955
Clay, fine, and sand		20	975
Sand		35	1,010
Clay, sticky, and sand		65	1,075
Total depth			1,075

Log No. 7.

Terry, No. 1, lessor

Fulton Oil & Gas Co., lessee.

Location: ½ mile east of Fulton and ½ north of Ky.-Tenn. line.

Authority: B. L. Andrews, Fulton, Ky.

Strata	Thickness	Depth
Quaternary System		
Soil and clay	80	80
Clay and sand	35	115
Clay and sand	20	135
Tertiary System		
Water sand, (good head water)	15	150
Clay	20	170
Sand, fine	20	190
Sand, fine	10	200
Sandy muck	40	240
Sand, very fine	10	250
Incomplete depth		250

15 in. casing set 60 feet.

12½ in. casing set 240 feet.

10 in. casing on ground to go 1,000 feet.

Will change to rotary drill soon.

McCRACKEN COUNTY.

Log No. 8.

Paducah Well.

Lessor unknown.

Lessee unknown.

Location: Within the city of Paducah.

Drilling completed in 1888.

Production: Dry.

Drilling samples collected by J. C. Farley and W. L. Bradshaw.

Authority: R. H. Loughridge, Ass't Geologist, Jackson Purchase Report of Kentucky Geological Survey, Series II, p. 321-326, pub. 1888.

Strata	Thickness	Depth
Quaternary System		
Loam, brown, micaceous	40	40
Gravel, rounded chert and quartz	20	60
Tertiary System		
Clay, black, and sand	90	150
Cretaceous System		
Clay and sand, micaceous, interlaminated	114	264
Chert, quartz, and pyrite debris	71	335

		Thickness	Depth
Mississippian System			
Limestone, shaly, white, fossils	Chester Group	90	425
Limestone, dark, impure, cavernous		45	470
Limestone, silicious, cavernous		48	518
Shale, dark, limy, fossils		32	550
Shale, white, limy, fossils		185	735
Limestone, blue, Pentremital		400	1,135
Limestone, blue, fractured, loose sand	(St. Louis)	115	1,250
Total depth			1,250

SUMMARY OF OIL AND GAS POSSIBILITIES.

A review of all the information now obtainable concerning the surficial and sub-surface geology of the "Jackson Purchase" region, allows the citation of the following points as having direct bearing on the possibilities of securing commercial quantities of oil and gas in this region: (1) All drilling completed to date has shown the sequence of unconsolidated embayment deposits in this region to be unproductive of commercial quantities of oil and gas. (2) Drilling depths to consolidated Mississippian limestones will vary from "0" on the outcrop, to about 2,270 feet in this section of Kentucky. (3) A thickness of from 1,800 to 2,300 feet may be expected to be encountered in the Mississippian limestones. (4) A thickness of from 100 to 200 feet may be expected to be encountered in the Devonian shales and limestones. (5) Well drilling to deeper "sands" than those of the Silurian is not recommended, though it is recognized that production might, as a remote possibility, be found. (6) Surficial structural figures such as anticlines, domes, faults, etc., as seen in the unconsolidated sediments of this region, may not be regarded as valuable or accurate criterions concerning the deformation of the Mississippian and lower rocks of the Paleozoic. (7) The sub-surface structure of the Paleozoic floor under the "Purchase" region is undoubtedly considerably faulted, the extent of which it is not possible to determine. (8) Associated with the sub-surface faulting of the "Purchase" region there occurs undoubtedly a certain degree of folding expressed in monoclinal, anticlinal and synclinal

LOWER REACHES OF MAYFIELD CREEK.

As it nears the Mississippi River in Carlisle County, this stream becomes sluggish and suffers from back-water during the Summer. It is flanked on either side by rather high bluffs of clays and gravels throughout this lower region.

figures, the exact location of which it is impossible to determine by surface observations. These structures may eventually be located by well drilling and the accurate plotting with casing head elevations of carefully kept records of all wells drilled. (9) In the present stage of oil and gas development of the "Purchase Region," no better method for oil and gas prospectors to go by than straight "wildcatting" is recognized. (10) All such "wildcatting" operations as may be undertaken in the future and their results, coupled with the well records of wells already drilled, when carefully studied, will serve as guides in selecting the locality and anticipating the general drilling conditions which may be expected to be encountered. (11) No close or reasonable connection is regarded as possible between the geology of the spectacular "Eldorado" oil field about 300 miles southwest, in Arkansas, and on the west side of the Mississippi River, and the geology known to obtain within the "Jackson Purchase" region of Kentucky.